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SUPPORTING THE SELECTION, ADAPTATION AND APPLICATION OF METHODS IN PRODUCT DEVELOPMENT

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Abstract

Besides personal means of method transfer in terms of individual coaching by trainers or consultants, impersonal transfer of product development method know-how by method-databases or further multimedia approaches is gaining in importance. Transfer of method know-how basically includes supporting the user in the fields of selection, adaptation and application of product development methods. In order to improve existing supporting systems, we analyse the basic mechanisms for method implementation especially focusing on the selection of product development methods. Further on we specify requirements for a problem, situation and user specific method adaptation and application. The elaborated results are introduced to a method model which is able to serve as a structural basis for a selection, adaptation and application supporting system. We identify method attributes as the key to link methods in-between each other. Thereby sets of method building blocks can be built up, which support the user by providing a tool for a guided navigation within the "method-content".

Keywords: design methodology, selection of methods, adaptation of methods, implementation of methods, structuring methods

1 Introduction

The application of working methods for product development and design has meanwhile proved its efficiency and effectiveness in field use. Although the application of these methods in practice is increasing and their acceptance by users is growing, especially in small and medium-sized enterprises use of product development methods isn't very established up to now. As one of the main reasons we regard the insufficient support in transferring method know-how to the user. This principally includes the guidance in choosing the appropriate methods as well as adapting them to the real life situation for a precise and successful application.

2 Situation and objectives

Up to now there are several approaches in non-personal systems to support the personal implementation of methods by trainers. Related Technical literature, method data bases or further multimedia approaches attempt to support the selection, adaptation and application of methods. The MAP-Tool [1] for example gives an overview over working methods structured according to the phases of the product life cycle.

In most cases however, these method libraries are limited to a more or less structured assembly of methods. The classification of the included methods into categories is the only guideline for selecting a method. As there is no further support in selecting or adapting a problem-adequate method, these method libraries do not achieve the potential that is undoubtedly behind the method knowledge in these libraries. Indications about "*what appropriate method should I chose and how can I use it in my actual case*" often do not appear until you enter a deeper level of the description of the methods. And just in case, filtering the relevant information in the descriptions occupies too much capacity. This situation leads to the conclusion that it is necessary to enhance the support of a problem-, user- and situation-oriented selection, adaptation and application of methods. For the development of a system, e.g. a web-based method database serving these requirements, it is necessary to exceed the currently existing assemblies and libraries regarding the method-contents. The system has to offer several views on the prevalent method network. Navigation tools are a further field of research which enable guidance in selecting the appropriate method and adapting it to the situation for a efficient and effective application.

In this paper we principally focus on the field of method selection. Describing different mechanisms, we give an idea of how to implement these ways of selection in a supporting system. Requirements concerning the adaptation and application of product development methods will also be discussed. The objective is to support the user in method selection, adaptation and application by providing a tool for a guided navigation within the "method-content".

3 Requirements

For transferring method know-how to the user, e.g. engineers in industry, there are several possibilities. Of course, the individual coaching of methods by trainers or consultants is superior to impersonal forms of method transfer, like literature, web-based method libraries or databases. Nevertheless method implementation and application by consultants or trainers is often limited to a specific existing repertoire of methods. This is the reason why methods often are applied that do not solve the actual problem.

For a problem-oriented and successful deployment of methods, the selection, adaptation, and application should always focus on the underlying situation and consider the boundary conditions. The use of unsuitable methods may lead to a loss of acceptance of methodical problem-solving in common. Another problem in this context is an insufficient clarification of the task before applying a method. This principally includes the clarification of conditions which determine method deployment. Objectives have to be identified so that it is possible to give indications for a precise selection, adaptation and application of methods.

4 Selection of methods

The selection of the "right" method is the fundamental basis for further steps in the methodical implementation of a task. In this chapter we would like to introduce mechanisms that especially support the selection of methods.

As shown in figure 1, we suggest three starting points for selecting methods. The "classic" way is to assign the considered task to an appropriate process in a superior process model. Process flows can concern different topics. The product development process for example, modelled in various facets, is one of the most occupied process models. Another way to choose the appropriate method is to compare the analysed task concerning its application conditions and boundary conditions with the associated method attributes. A third mechanism that leads to an adequate method selection is to scan the underlying task for its required basic tasks and oppose them to corresponding elementary method tasks.

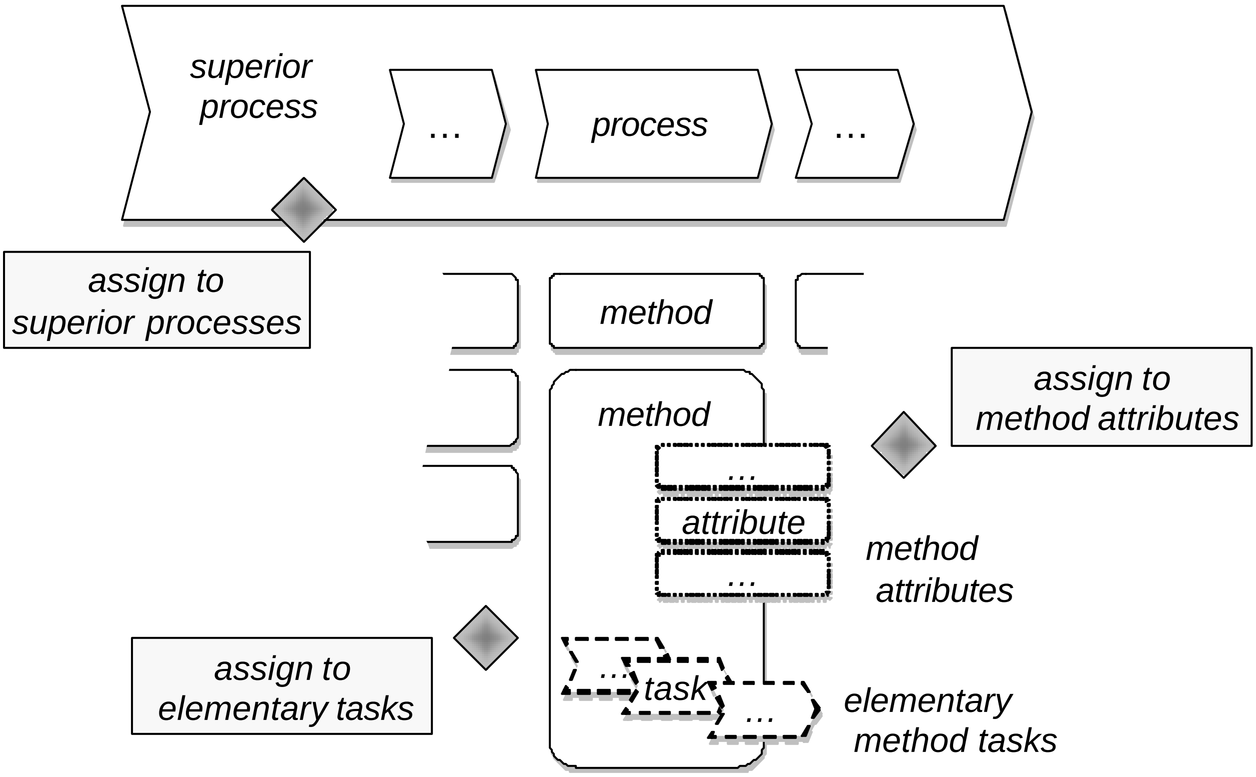

Figure 1. Starting points for method selection

4.1 Method selection by assignment to a superior process

For selecting methods to support the implementation of a task, it is the most practiced way to analyse the considered task and assign it to an adequate process in a superior process model. In this case, the principle is to utilise the classification of methods for "navigating" to the appropriate method. Up to now various method libraries were developed based on a more or less detailed classification of methods by using process flows or other structuring criteria.

Figure 2 shows this first mechanism for method selection. In this exemplary case, the considered task is to "*search solutions for the design of a technical system*". Looking for method support it is possible to consider the product development process e. g. according to the guideline VDI 2221 [2]. Underneath the process step "*search for solution principles and their combinations*" we can find a set of methods that refer to the considered task.

Classification of methods means to assign each method to a certain category or class of methods. These categories can concern process flows as well as application fields or other "classes" of methods. Of course a lot of methods can be applied not only in one but in various cases. In literature we find several approaches trying to classify methods [3]. The composition of method classifications or method synopses is a hard job, especially when the elaborated method classification should be suitable multidisciplinary.

By picking up this assignment of methods to superior processes – especially to the product development process – method data bases or further multimedia approaches attempt to support this way of selecting methods. Unfortunately in most cases the classification of the included methods into categories is the only guideline for selecting a method. This situation leads to the conclusion that it is necessary to enhance the support of a problem-, user- and situation-oriented selection by providing further views on the prevalent method-network.

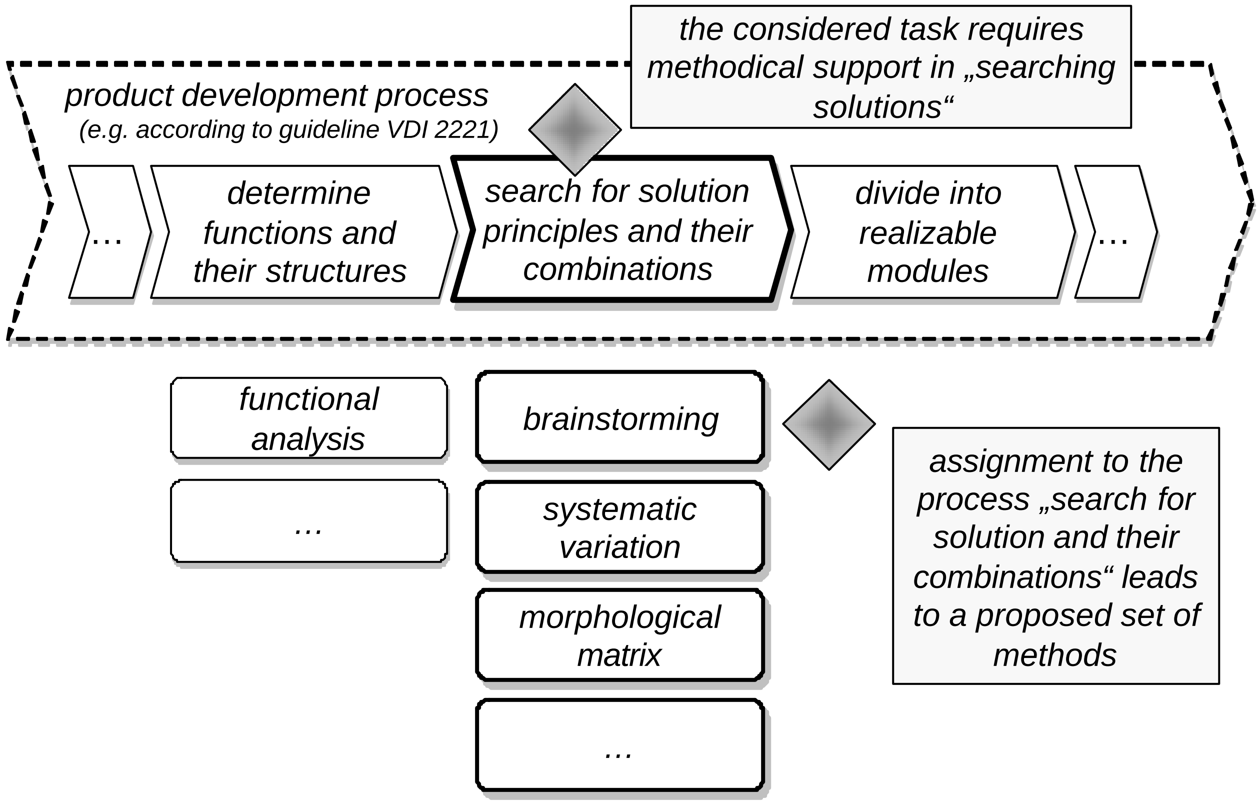

Figure 2. Method selection by assignment to a superior process

4.2 Method selection by assignment to method attributes

A continuative way to choose the appropriate method for working out a task is to compare the analysed considered task concerning its requirements, preconditions, application conditions, boundary conditions and target conditions with associated method attributes. As we already mentioned, the clarification of the task is the indispensable prerequisite to reach an efficient and effective method application. This in particular includes the clarification of the method deployment. The conditions that determine the implementation of a method have to be analysed.

Figure 3 shows the result of the analysis of method deployment conditions in an exemplary case. The underlying task is to "*develop a solution concept*". In this case, an existing input for the implementation of a method would be a set of existing partial solutions, which is the output of a previous process. In the example, the existing team which already developed the input solutions consists of at least three product designers and is ready to perform the upcoming task. Besides these boundary conditions which are decisive for the application possibilities of a method, there are also objectives of a potential method implementation. In our case, it is the target to systematically arrange the existing partial solutions and combine them to a complete solution concept.

The next step to come to a method selection is to assign the identified conditions to corresponding method attributes. As method attributes, we regard a set of characteristic information and properties which specify a method. In literature method attributes are also addressed as method characteristics or features. Method features e.g. can be arranged into two classes: features which characterise the method as a tool and features which characterise the method as information [4]. In our case, as also described later on, we distinguish between attributes which are particularly relevant for the selection of a method and attributes which mainly concern the adaptation or application of a method. In the present case, we focus on the method attributes concerning the requested input, the requested resources and the achievable output of a method.

Opposing the identified conditions to the associated method attributes allows coming up to a selection of an appropriate method. In the present case, the morphological matrix would be chosen to perform the considered task.

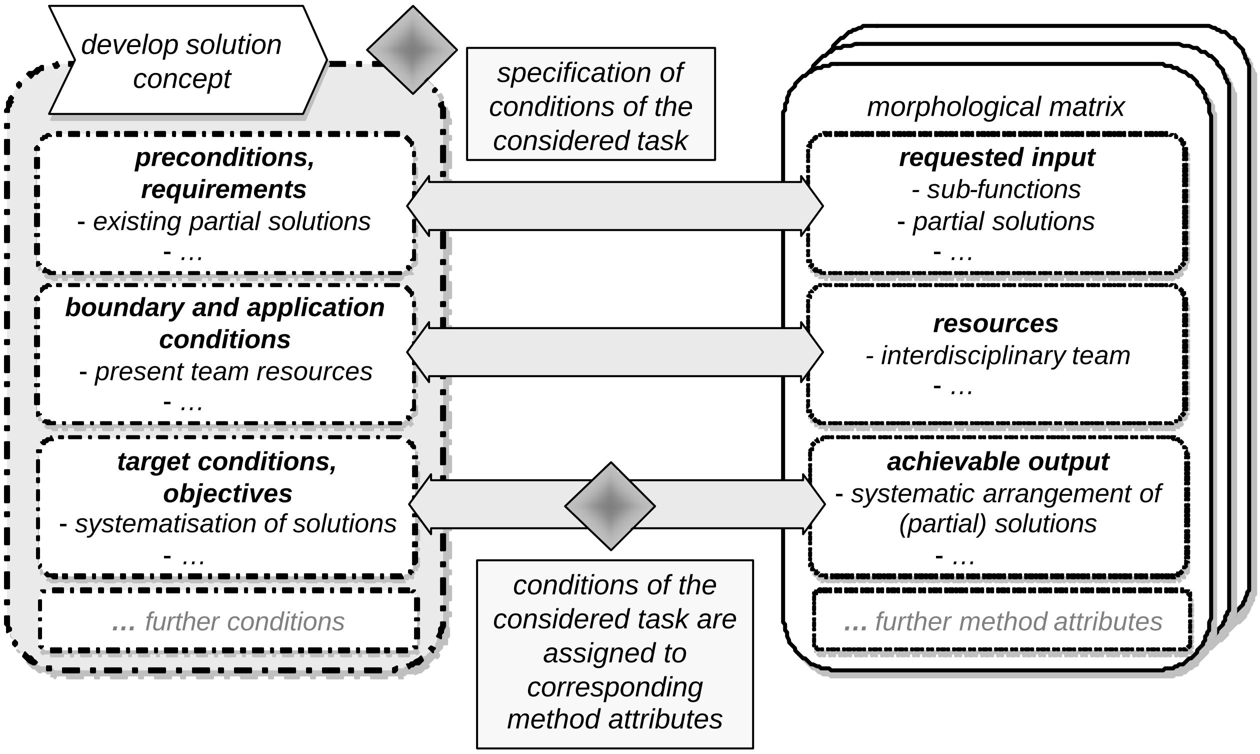

Figure 3. Method selection by assignment to method attributes

Method attributes are a comfortable starting point for the navigation to an appropriate method. Whereas classifying methods into categories is a difficult job, the handling of method attributes is characterised much easier. Furthermore method attributes can be easily deposited in supporting systems, e. g. method databases. By the utilisation of standard terms for the characterisation of the attributes it is also possible to apply acquainted search mechanisms.

In the above presented example method attributes are applied, which characterise the deployment of a method mainly concerning its input and output information as well as its characteristic application information. Of course it is conceivable to pick up some further attributes e.g. focusing on the active principle of a method. Classifications and synopses of methods give an idea of other derivable method attributes. The required degree of intuition for the application of a method is another example for a method attribute that can be applied for the selection of a method.

4.3 Method selection by assignment to elementary tasks

To carry on the depiction of possible mechanisms for method selection we would like to emphasise a further alternative. Up to now various theoretical approaches appeared, where methods are analysed and divided into their basic modules, often called elementary methods or elementary tasks. These elementary tasks are defined as inseparable elements describing the basic procedures "inside" methods. Thereby research work mostly concentrates on the situational adaptation and combination of product development methods [5].

Using elementary method tasks for method adaptation leads to the question, why not using them for the selection of methods? Just as mentioned above, the clarification of the considered task is an essential prerequisite. In this present case the clarification has to focus on basic tasks which are required to process the considered task. The next step is to pick out relevant tasks of a pool of elementary method tasks. By comparing the required basic tasks with the elementary method tasks or combinations of elementary method tasks the selection of a method can be supported.

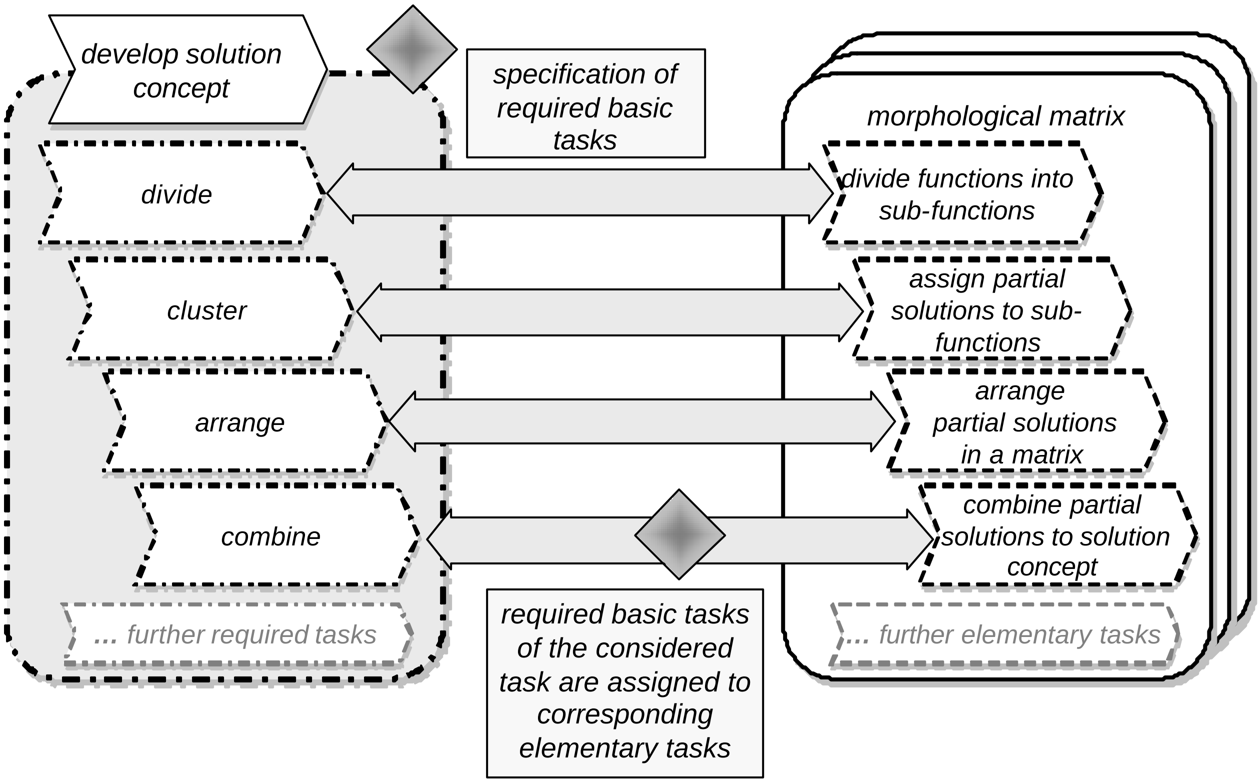

Figure 4. Method selection by assignment to elementary tasks

For the implementation of the considered task „*develop solution concept*" the basic tasks *divide, cluster, arrange* and *combine* can be specified as show in figure 4. The morphological matrix seems to support the demanded tasks by its underlying elementary tasks. Therefore it would be chosen in this exemplary case.

5 Adaptation and application of methods

Besides method selection, the problem-, user- and situation-specific adaptation and application of methods is decisive for an efficient and effective method implementation. Hence the transfer of method know-how has to exceed the sole selection.

Mechanisms for the adaptation and application of product development methods are another field of research. In this paper we mention basic conditions of adapting and applying methods in product development.

As illustrated in figure 5, the adaptation of methods principally gets influenced by the application conditions and boundary conditions. In coordination with the associated method attributes (mainly *resources* and *procedure*) the user must be instructed, how to adapt the chosen method to the present conditions in a best possible manner.

Adapting the selected method to the clarified boundary conditions often leads to a "new" method. Varying the elementary tasks of brainstorming e.g. may lead to the "new" method "6-3-5".

With increasing complexity of methods and methodologies, the adaptation to the present situation gets more and more important as well as extensive. The above described approach to concentrate on elementary tasks seems to be a reasonable way to capture adaptation efforts.

The application of already selected and adapted product development methods can be supported in different ways. Besides the individual coaching of methods by trainers or consultants impersonal forms of application support, like literature, web-based method libraries or databases pick up this challenge by providing various assistance tools.

A basic prerequisite for method application is the availability of method application know-how in different manners. For an efficient use of method-know the method representations like abstracts, presentations, work sheets, software tools, etc. have to be built up user-oriented and in a way that supports the practical use. Therefore method representations have to be deposited in different granularities, depending on user requirements. The method model in figure 5 highlights the method attributes, which are affected by method application.

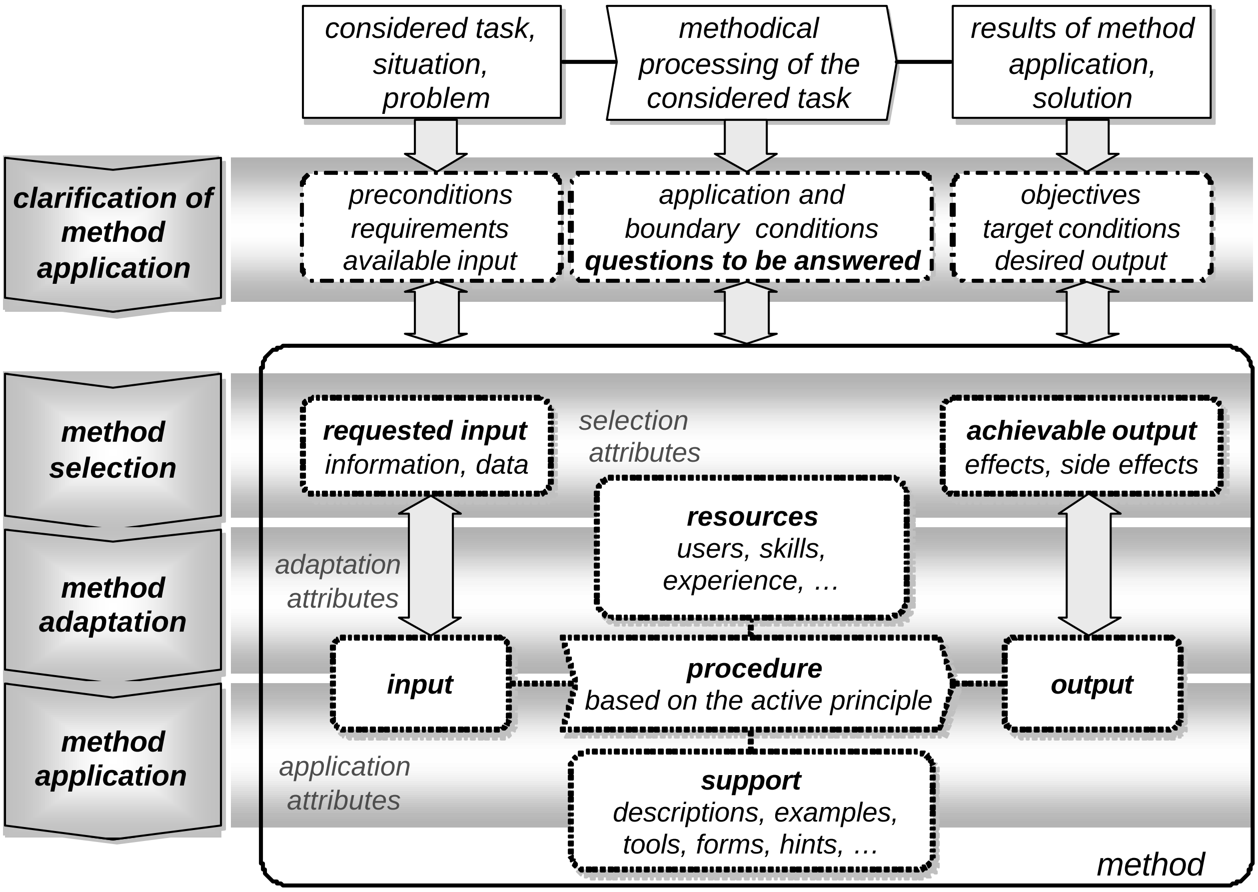

Figure 5. Implementation of the Munich Model of Methods

6 Supporting the selection, adaptation and application of methods

Improving the support of method transfer requires the implementation of the described selection mechanisms in a supporting system additionally considering the requirements for adaptation and application of methods. As we came to the conclusion that the availability of method know-how is a basic prerequisite, the supporting system has to provide the method-content in a structured and modular way. For structuring the method-content many approaches emerged; e.g. the process-oriented method model [6] gives a broad overview of method attributes.

We would now like to introduce a model that correlates method attributes with the process steps of method deployment (namely selection, adaptation and application). The implementation of the so-called *Munich Model of Methods* (MMM) as shown in figure 5 gives an overview of a method concerning its method attributes in the intersection of methodical implementation of a considered task (horizontal lane) and the required process building blocks (vertical lane: clarifying the method application, selecting, adapting and applying a method).

The point of origin is given by a present task/problem in product development characterised by its specific situation. To solve the problem with the aid of working methods claims to reach the desired results. As we already pointed out in the above chapters, the essential prerequisite for implementing a method is a detailed clarification of the task. This clarification especially has to focus on the conditions which influence the method application. Concerning the situation, the methodical processing of the task and the results we can analogously derive conditions for the method application. The analysed conditions can be opposed to the corresponding method attributes. In this matter method attributes become a "docking station" for selection mechanisms as well as adaptation and application proceedings.

The attributes in the method model (cp. figure 5) and their discussed arrangement in the model are building the basis for the method-content in the so-called CiDaD-tool (Competence in Design and Development). CiDaD is an interactive web-based method data-base, which is currently in development at the institute for product development at the Technical University Munich [7]. Regarding method selection, CiDaD already picks up two of the above exemplified mechanisms. First of all the "classic" mechanism – assignment to a superior process – is realised. The superior process, an improved variant of the common product development process, is structured by the *Munich Procedural Model* (MPM) [8]. The different process building blocks in the model are presented as courses in the system. These courses allow arranging the present task into the context of the product development process. Dynamic linking mechanisms are implemented in the course environment, which indicate corresponding working methods. The linking mechanisms are another field of research.

Further on the utilisation of method attributes as a second mechanism for the selection of methods has been tested out. Input and output information are deposited in the system as input and output keywords. By entering these keywords, appropriate methods are highlighted. Experiences in this field show, that an improved linkage between method attributes is desirable. Advanced selection mechanisms hardly will come up without close coordination to the opportunities of the development of the underlying technical system.

In order to obtain support in method selection by assigning the required basic tasks to elementary method tasks, efforts are made. The above mentioned courses, which refer to contents in product development, get restructured in a way that encourages the assignment to elementary tasks. It cannot be the objective to invent new methods or give new names to existing ones, but it is rather the necessity to "illuminate the method haze" by focusing on the elementary tasks and principles that "hide inside" methods. For a descriptive illustration the elementary method tasks can be formulated in an interrogative form.

Having a look at the processes in practice e. g. in small and medium sized enterprises, we notice that product developer often refuse to deal with single elementary methods or method building blocks. Sets of methods are requested to work out a certain superior subject. Picking up this requirement a further approach is to provide method sets to support the methodical implementation of superior tasks. For a detailed clarification of the task in this case checklists can be applied which lead to a selection of a guideline as "a way through the method network".

The described attributes are the basis for a network of method building blocks: e.g. output information, documents and other output artefacts very often refer directly to the input information of another method building block that should be addressed in the actual context. Thereby method building blocks are linked. Concerning further attributes, the mechanisms are similar. This cross-linking principle is the basis for describing the interrelations between the particular method building blocks. To support a problem-oriented method application it is possible to use this network of method building blocks for the required navigation tool, the guideline.

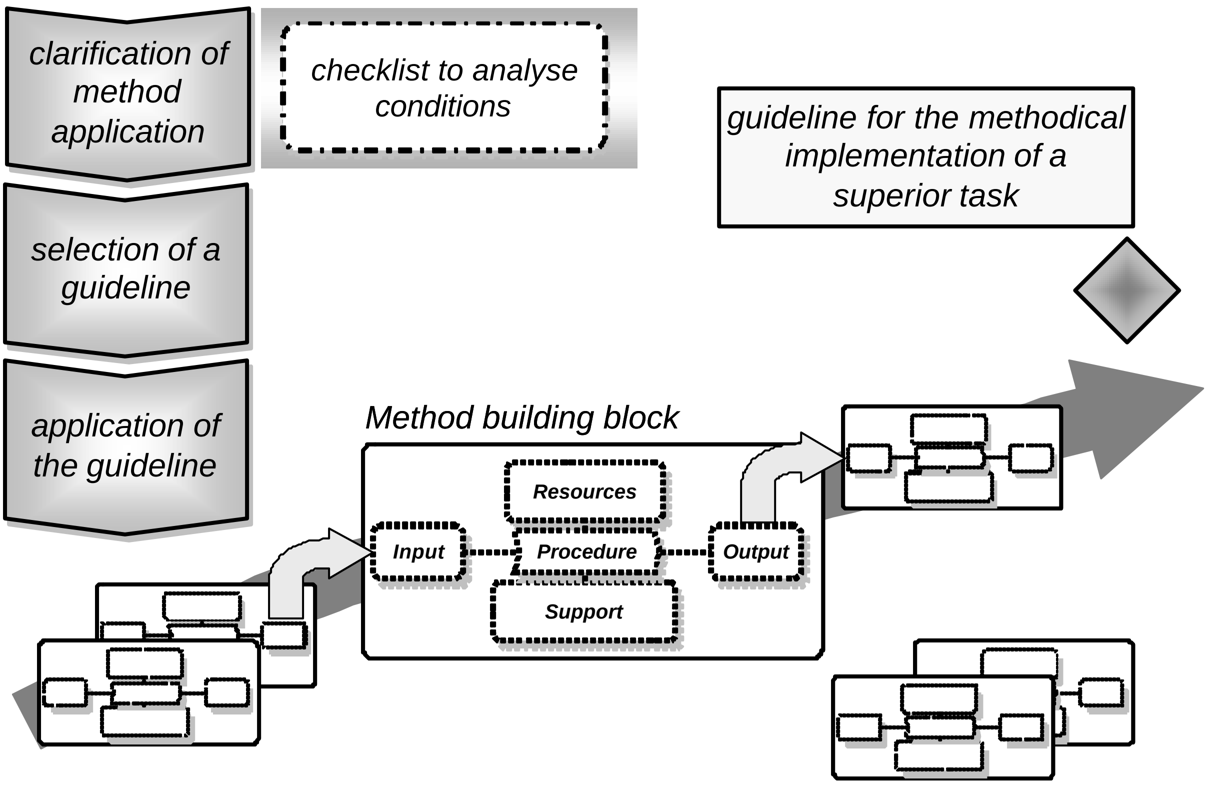

Figure 6. Guidelines for methodical implementation of superior tasks

7 Conclusion

In summary the introduced approach leads to the following key conclusions. Actual transfer of method know-how suffers in supporting the user in selecting, adapting and applying the working methods for product development. Besides the individual implementation of methods by trainers, consultants, etc. (which cannot be substituted but only supported) the transfer of methodological know-how by the means of supporting systems has to be enhanced. For an effective and efficient method application the selection and adaptation of methods concerning specific situations and conditions has to be supported by such systems. Therefore the underlying method-content has to be deposited in a structured and modular way. Selection mechanisms should focus on a combination of several selection alternatives. Assignment to a superior process as well as assignment to method attributes or elementary method tasks are reasonable mechanisms. Method attributes are the key to link methods in-between each other. Guidelines for a problem-oriented method application are based on the network of method building blocks and include instructions for a situation-specific navigation through the method network. The so-called CiDaD-tool (Competence in Design and Development) is an interactive web-based method data-base, which is currently in development at the institute for product development at the Technical University Munich. It aims on picking up this approach. Based on a detailed clarification of the task and the boundary conditions, it is the objective of the system to provide an instrument that supports the selection of the appropriate method and gives an idea how to use it in an actual situation to come to a best possible solution for the problem.

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